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ABSTRACT

The development of the concept of seriation was studied for 415 children, ranging in age from 3 to 9 years. The subjects were required to learn to identify the larger or smaller object in a two stimulus series, the smallest or middle-sized object in a three stimulus series, and the largest or next to the smallest in a four stimulus series. The end positions of the series were significantly easier to identify than the inner positions. The four stimulus series was significantly more difficult to learn than a three stimulus series only in the cases in which the subject was required to identify an inner position, but not when he was required to recognize an end position. (Author)

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THE DEVELOPMENT OF THE CONCEPT OF SERIATION[1]

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The ability to order objects in a series according to some dimension, such as size, is recognized as an important aspect of a child's ability to understand logical concepts. In studies such as Elkind's (1964), Inhelder and Piaget's (1964), Murray and Youniss' (1968), and Piaget's (1965), it has been found that a child cannot perform a task that involves the concept of seriation until the age of 6 or 7. Below the age of 4 or 5, children appear to have no concept of seriation, even in a series with a small number of objects.

The instructions in these seriation tasks usually involve directing the child to put the objects "in order from the biggest to the smallest" or "build a stairway" with the objects. One of the possible reasons for children's failure to perform these seriation tasks successfully is the relative difficulty of the language involved in communicating this concept to the child. In order to examine the child's understanding of seriation concepts, a task was developed, based on the work of Siegel (1971), that was designed to test certain seriation concepts, but in which there was a minimum amount of verbal instruction to the child. For the purposes of this study, seriation was operationally defined as the child's ability to learn to choose a particular position, e.g., smallest, in a two, three, or four object series.

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Method

Sample 1

Subjects

The subjects were 90 children from nursery schools in Hamilton, Ontario,

30 children from each of three age levels - 3, 4, 5 year olds. Within each age group, there were six subgroups, each composed of three boys and two girls, who received the experimental treatments described below. The subjects were white, of middle class backgrounds and of average or above average intelligence, according to teacher's estimates.

Tasks

Each subject was administered three seriation tasks that tested his ability to recognize a particular position in a series. The tasks were administered with a Behavioral Controls 400-SR programmed learning apparatus. There were four response panels covered with clear plastic press panels. The child responded by pressing the panel over the stimulus of his choice. Correct responses were rewarded with Smarties (the Canadian version of M & M's). A non-correction procedure was used and the position of the correct alternative varied randomly from trial to trial.

Each child was administered three seriation tasks with two, three, or four stimuli in the series. The stimuli for the tasks were vertical bars of nine discriminably different heights. For all the tasks, the stimuli for each trial were randomly selected from the nine possible so the particular combination of stimuli presented on each trial varied randomly. On a particular trial, the stimuli were not presented to the child in a sequence ordered by size. Depending on his random assignment to an experimental condition, a subject could be reinforced for either the larger or the smaller in the two stimulus series, either the middle-sized or the largest in the three stimulus series, and either the largest or the next to the smallest in the four stimulus series.

There were six subgroups for each age; one half of the subjects at each age level were administered the following set of tasks: two stimulus series - smaller, three stimulus series - middle-sized, four stimulus series - largest,

and the other half were administered the following set of tasks: two stimulus series - larger, three stimulus series - smallest, four stimulus series - next to the smallest. This method of counterbalancing was chosen to minimize transfer between tasks. For each of the conditions, the tasks were administered to different subjects in three counterbalanced orders making six subgroups in all. Before each task, the subject was instructed that he would receive a candy for choosing the (biggest, littlest, middle-sized, next to the littlest) picture.

Procedure

All the subjects were tested individually. Criterion for all tasks was nine out of ten consecutive correct responses. If the child failed to achieve criterion in 60 trials, the task was terminated.

Sample 2

Subjects

The subjects were 325 children ranging in age from 4 to 9 years old who were participating in summer recreation programs in Hamilton, Ontario. For purposes of analysis, the subjects were divided into six age groups: 4 years, 17 males and 17 females; 5 years, 22 males and 26 females; 6 years, 24 males and 30 females; 7 years, 31 males and 22 females; 8 years, 36 males and 31 females; 9 years, 32 males and 37 females. The subjects were white, from lower and middle class backgrounds and, according to teacher's estimates, were of average intelligence.

Tasks

The tasks and procedures were the same as with sample 1 with the exception that each subject was administered only two tasks - the three stimulus series and the four stimulus series, since the problems in two stimulus series were solved quite easily by the subjects in sample 1.

Results

The means for number of trials to criterion for the six tasks administered to sample 1 are shown in Figure 1. Subjects who failed to reach criterion on

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Insert Figure 1 about here

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a particular task were assigned a score of 60. A series of analyses of variance was performed on these data. In the two stimulus series, there was no significant difference between the task that required selection of the smaller stimulus or the one that required selection of the larger stimulus ($F < 1$, df = 1, 84). In the three stimulus series, the task that required selection of the smallest stimulus was significantly easier than the one in which the middle-sized one was correct (F = 43.30, df = 1, 84, $p < .001$). In the four stimulus series, the task in which the subject was reinforced for choosing the largest one was significantly easier than the one in which the next to the smallest was reinforced (F = 165.55, df = 1, 84, $p < .001$). Therefore, in the three and four stimulus series, the end position of a series was significantly easier to learn than the inner positions.

There was no significant difference between the tasks in which the end positions were reinforced (three stimulus series - small vs. four stimulus series - large, $F < 1$, df = 1, 84) for any age group. However, there was a significant difference between the tasks in which the central positions were reinforced (four stimulus series - next to the smallest vs. three stimulus series - middle-sized F = 10.41, df = 1, 84, $p < .005$) for all age groups. In this latter case, the three stimulus series was significantly easier than the four stimuli one. Therefore, the length of the series affects performance in a seriation task only when the inner position is being reinforced.

The mean numbers of trials to criterion for the four tasks administered to the children of sample 2 are shown in Figure 2. A series of analysis of

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Insert Figure 2 about here

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variance was performed on these data. As in the previous sample, for series of both lengths, the end positions were significantly easier to learn than the inner ones. In addition, the longer series were more difficult when an inner position was being reinforced than when an end position was reinforced.

For both samples, there were no significant differences between the means of males and females for a particular task, and no significant effects of task order (t-test for independent means).

Discussion

A child's performance in a seriation task depends on the particular position which he is required to identify and on the length of the series. Even the youngest children in this study, the 3 year olds, had relatively little difficulty identifying the end positions of the three and four object series, but the inner positions of the series were difficult to identify for all the children except the older age groups.

With reference to series length, the four stimulus series were more difficult to learn than the three stimulus series only in the case in which the subject was required to identify one of the inner positions. The series used in this study were composed of fewer objects than are used in the typical seriation task, so that further research is needed to determine fully the importance of this variable.

The tasks used in the present study differed from the usual seriation ones in that the child was required to consider only one position of the series.

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Although this appears to have made the task much easier, the child had to be able to order the stimuli on a particular trial to be able to choose the proper position. Furthermore, the tasks in this study, unlike the typical seriation ones, were true relational tasks in that a particular stimulus was not always the largest, smallest, middle-sized, or next to the smallest but its position varied from trial to trial depending on the stimuli for that trial.

According to the results of the study, children as young as three years can learn a seriation task when the verbal requirements of the task are minimized, and the difficulty experienced by the children with the concept of seriation can be reduced by using non-verbal testing methods.

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Footnotes

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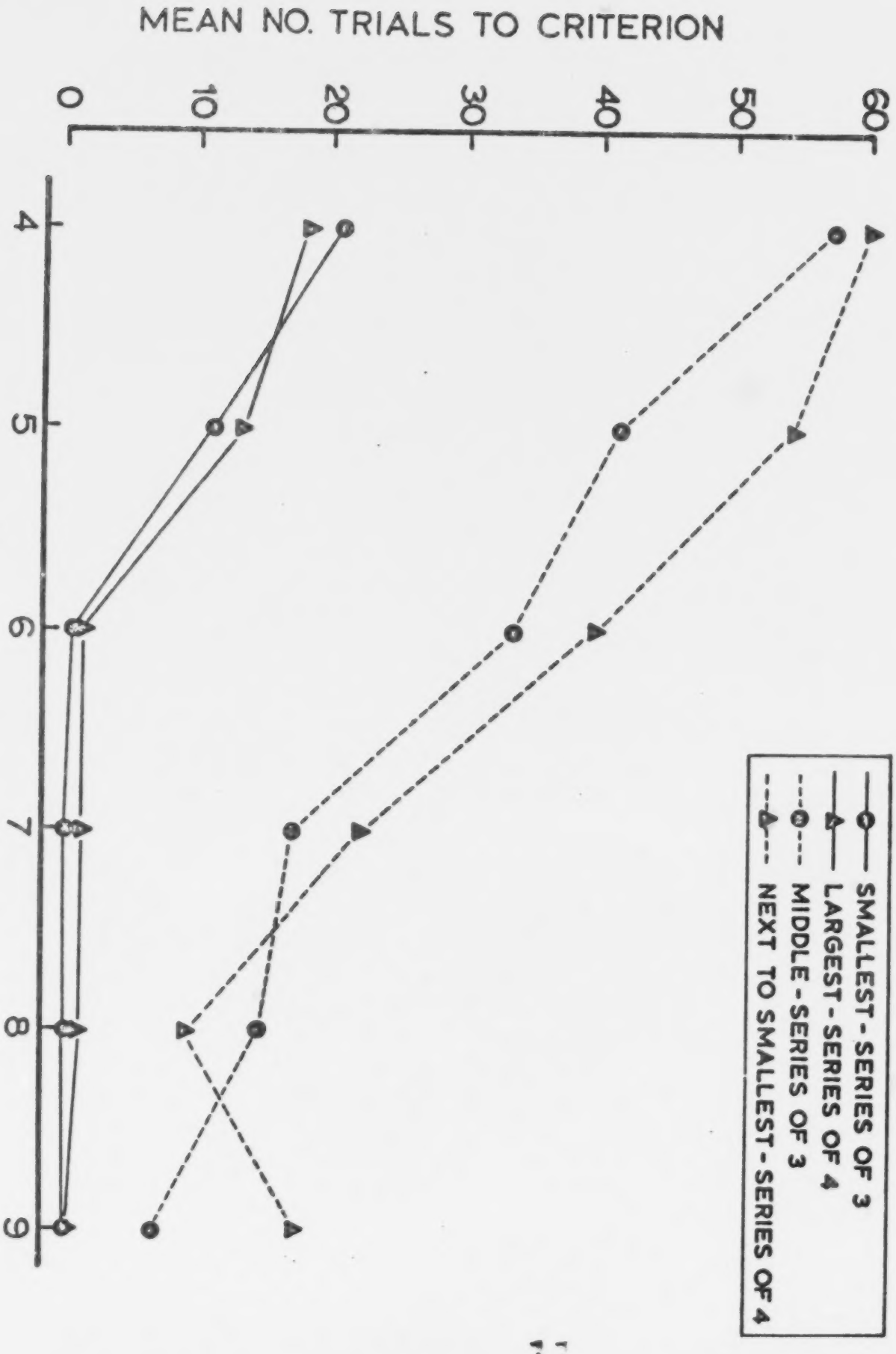
Figure Captions

Figure 1. The mean number of trials to reach criterion on the tasks as a function of age for sample 1.

Figure 2. The mean number of trials to reach criterion on the tasks as a function of age for sample 2.


MEAN NO. TRIALS TO CRITERION
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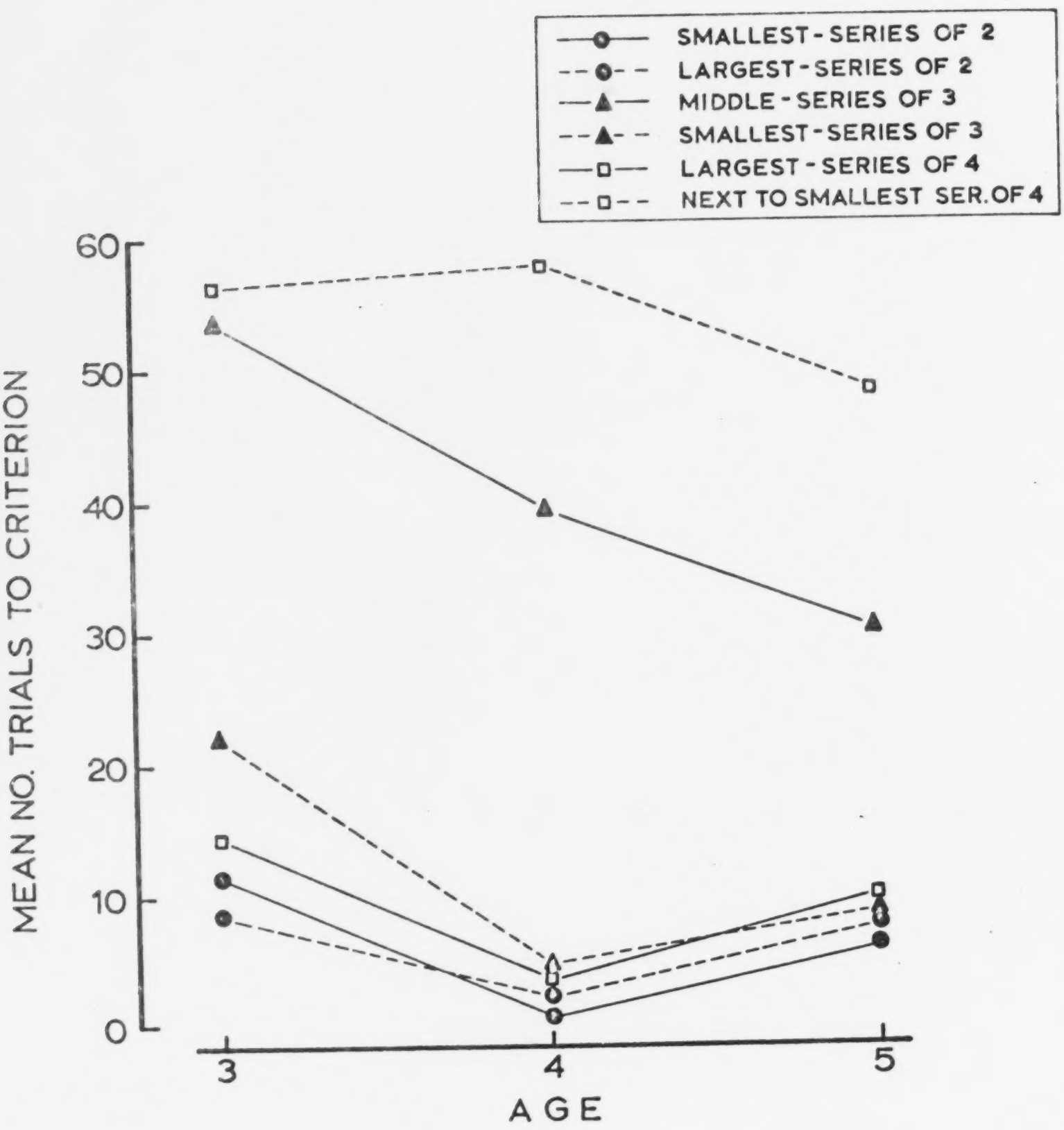
20
30
40
50
60
4
5
6
7
8
9
AGE
SMALLEST - SERIES OF 3
LARGEST - SERIES OF 4
MIDDLE - SERIES OF 3
NEXT TO SMALLEST - SERIES OF 4


SMALLEST - SERIES OF 2
LARGEST - SERIES OF 2
MIDDLE - SERIES OF 3
SMALLEST - SERIES OF 3
LARGEST - SERIES OF 4
NEXT TO SMALLEST SER. OF 4
MEAN NO. TRIALS TO CRITERION
60
50
40
30
20
10
0
3
4
5
AGE